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SPACE STATION CREW SAFETY
HUMAN FACTORS INTERACTION MODEL

Abstract by Marc M. Cohen and Maria K. Junge

Space Human Factors Office

NASA-Ames Research Center

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As NASA prepares plans to develop a space station, one of the major Human Factors study tasks is to develop an approach to Crew Safety. NASA has always been a paradigm of safety consciousness and recognizes that safety will be a key to reliability and human productivity on the space station.

In evaluating safety strategies, it is also necessary to recognize both qualitatively and quantitatively how this space station will be different from all other spacecraft. During the initial phase of this study, it was recognized that the major difference between space station and previous spacecraft is the role of human factors and extra-vehicular activity (EVA). In this project, a model of the various human factors issues and interactions that might affect crew safety is developed.

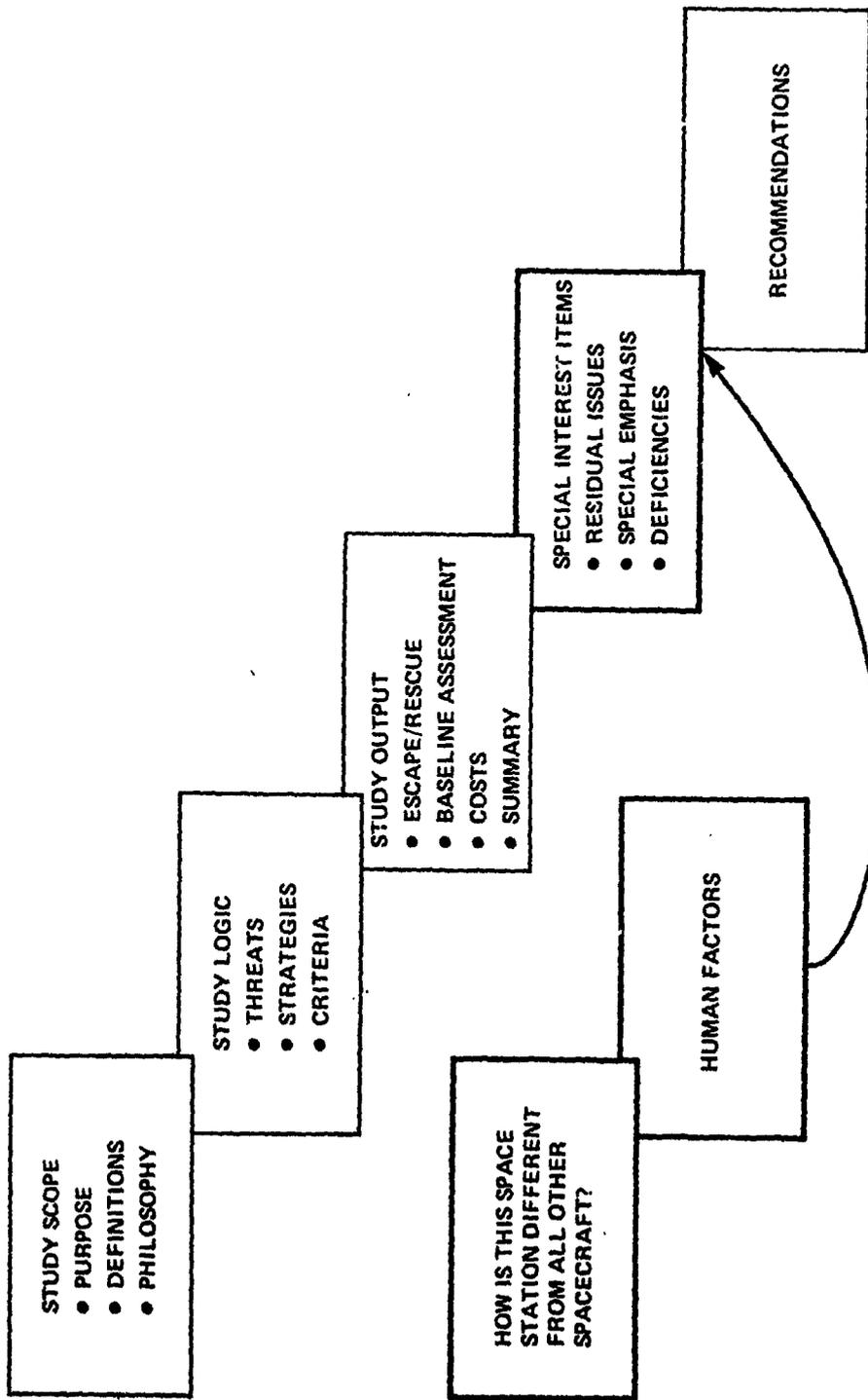
The first step addressed systematically the central question: How is this space station different from all other spacecraft? A wide range of possible issues was identified and researched. Five major topics of human factors issues that interacted with crew safety resulted: *Protocols, Critical Habitability, Work Related Issues, Crew Incapacitation and Personal Choice.*

Second, an interaction model was developed that would show some degree of cause and effect between objective environmental or operational conditions and the creation of potential safety hazards. The intermediary steps between these two extremes of causality were the effects on human performance and the results of degraded performance. The model contains three milestones: stressor, human performance (degraded) and safety hazard threshold. Between these milestones are two countermeasure intervention points. The first opportunity for intervention is the countermeasure against stress. If this countermeasure fails, performance degrades. The second opportunity for intervention is the countermeasure against error. If this second countermeasure fails, the threshold of a potential safety hazard may be crossed.

An example of how this interaction model works can be demonstrated. Under *Critical Habitability*, the primary environmental stressors include confinement, isolation and separation from earth. There are two subgroups of within the first countermeasure against these stressors, social and architectural interventions. The social factors are communication with family and friends, visitors to the station and recreation. The architectural factors are design, station geometry and "local vertical" reference orientations and windows. When these social and architectural design level countermeasures against stress are not effective, crew performance may degrade in the form of morale deterioration, impaired

judgement or faulty perceptions. The second set of countermeasures, against errors are operational or group social activities plus personal existential actions. These social subset countermeasures include group activities, hobbies and time for personal interests. The design/physical countermeasure subgroup includes color coding on interior functions, lighting and video systems. To the extent that this second defense of countermeasures is not successful, the threshold of potential safety hazards may be crossed. In this instance, potential safety hazards include a breakdown in group process and teamwork, and mistakes occurring in judgement, perception or action.

The third step, which is now in progress, is to apply a system of weighting to the various stressors and countermeasures in order to be able to evaluate their relative importance. This weighting will also require an element of time duration to identify which stressors or countermeasures are relevant at the beginning, middle or end of missions, and which are short-lived or chronic in nature.

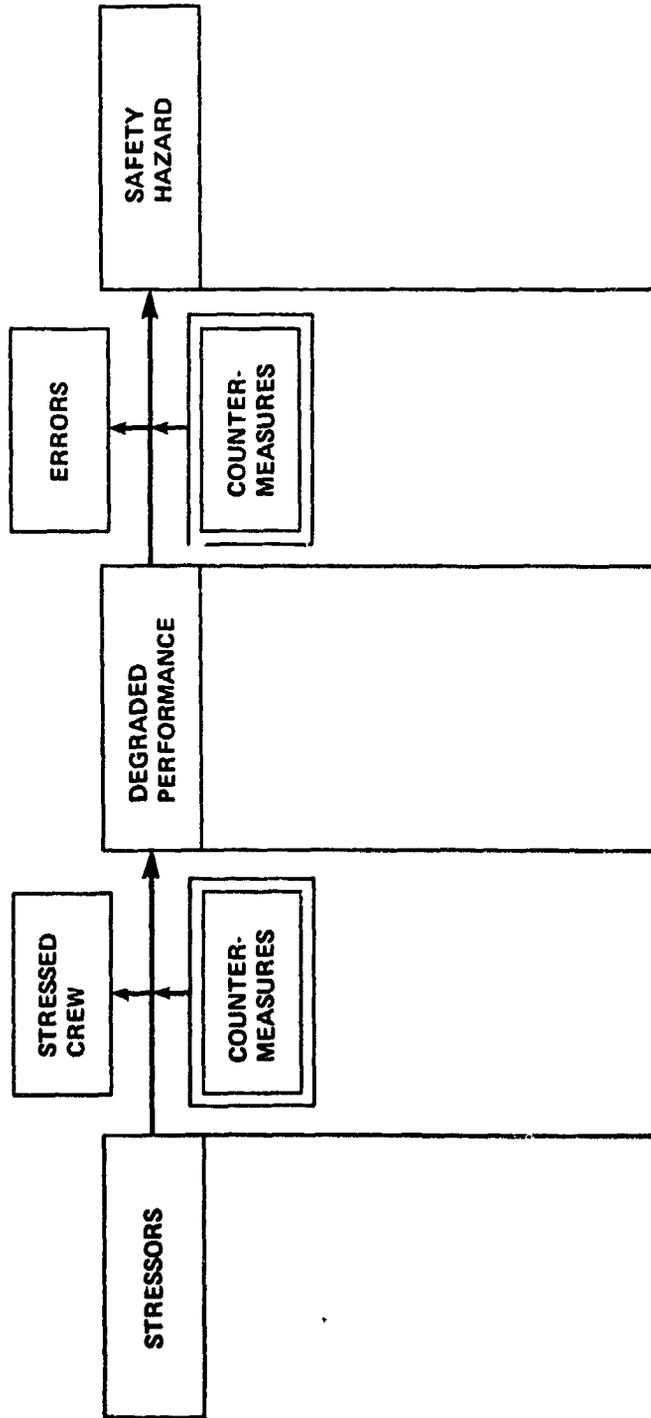


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SPACE STATION CREW SAFETY HUMAN FACTORS CONCERNS

1. PROTOCOLS
 - AUTONOMY FROM GROUND
2. WORK RELATED ISSUES
 - TASK ASSIGNMENT
 - ROLE DEFINITION
3. CRITICAL HABITABILITY
4. CREW INCAPACITATION
5. PERSONAL CHOICE
 - INDIVIDUAL SCHEDULE CHANGES
 - OPERATIONAL CHANGES
 - WORK PROCEDURE CHANGES

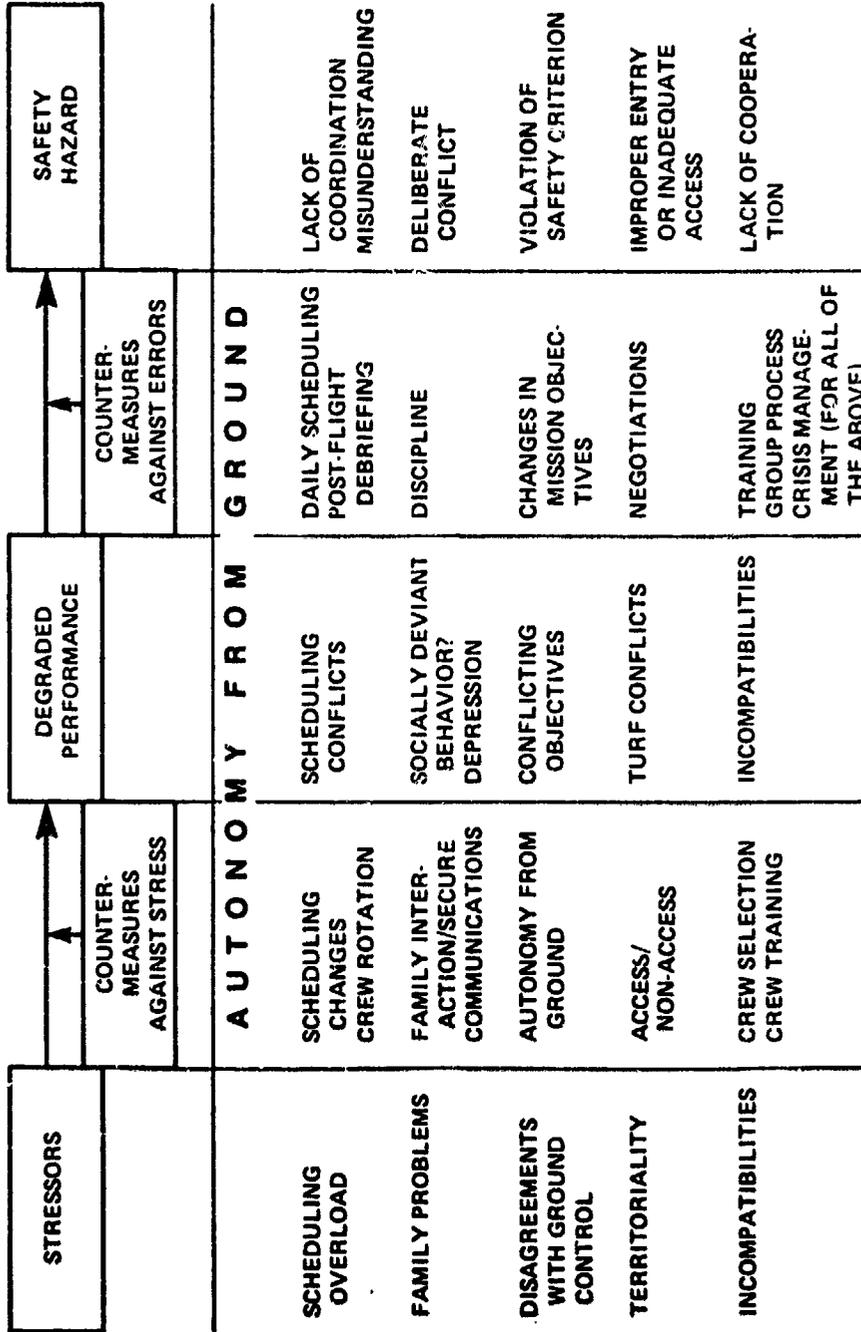
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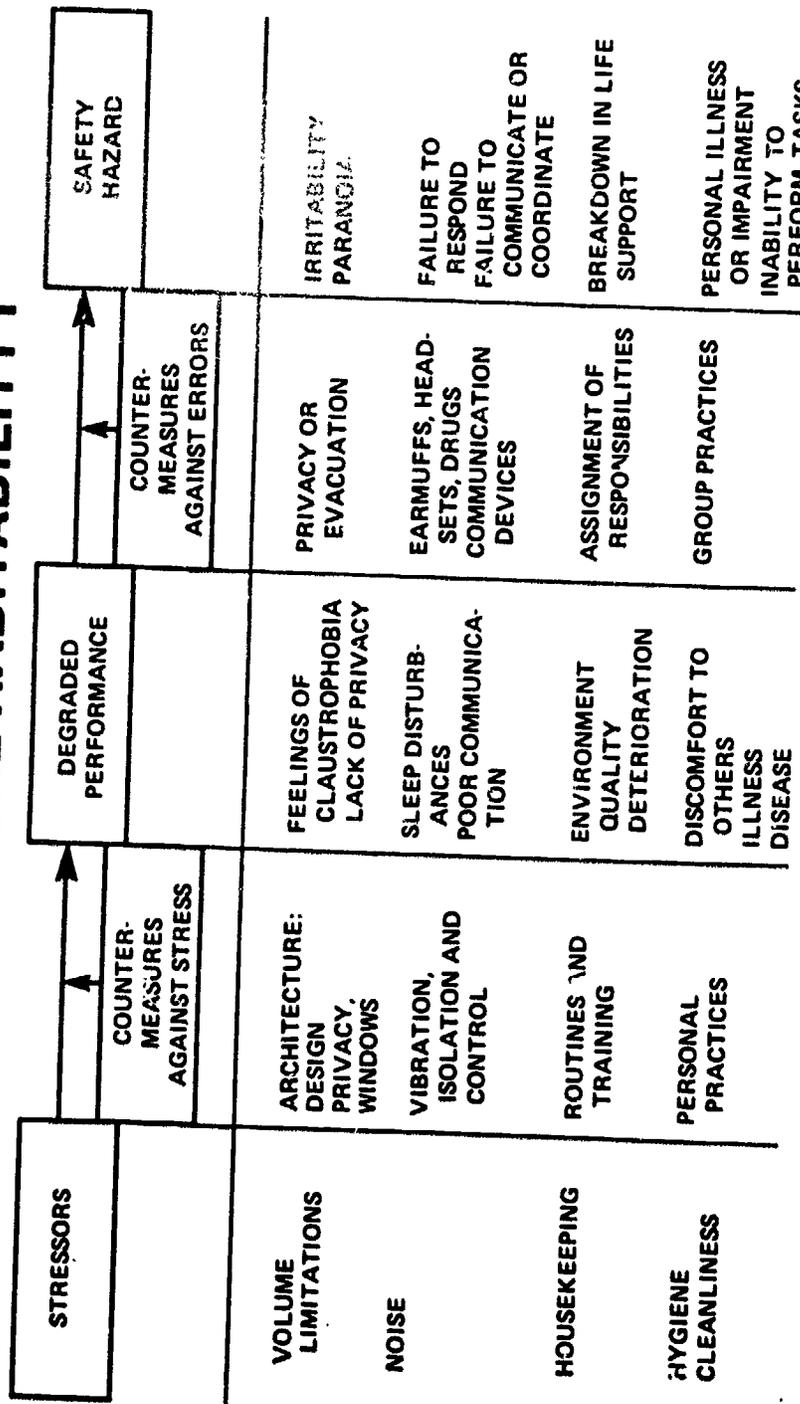
1. PROTOCOLS



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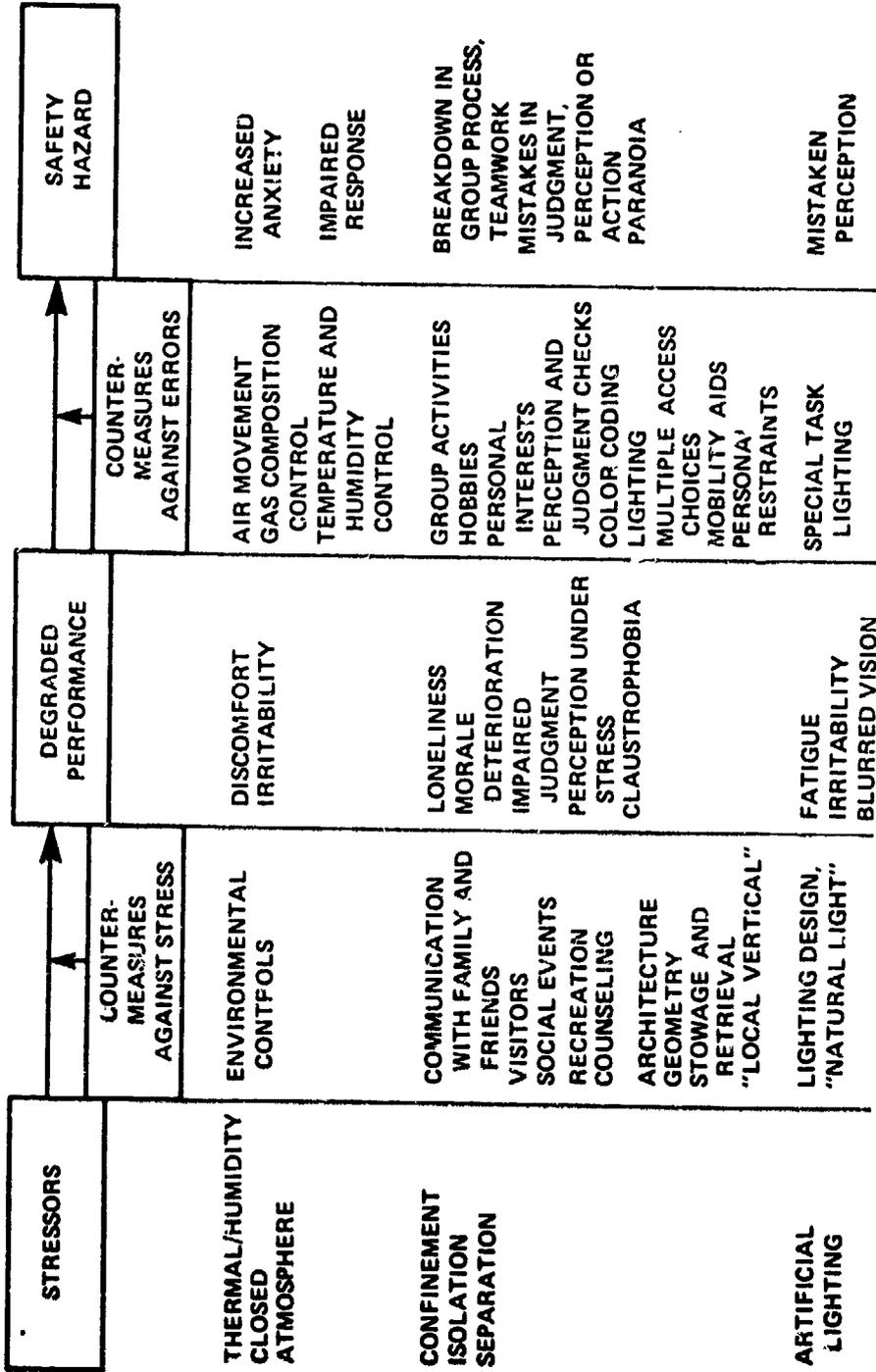
2. CRITICAL HABITABILITY I



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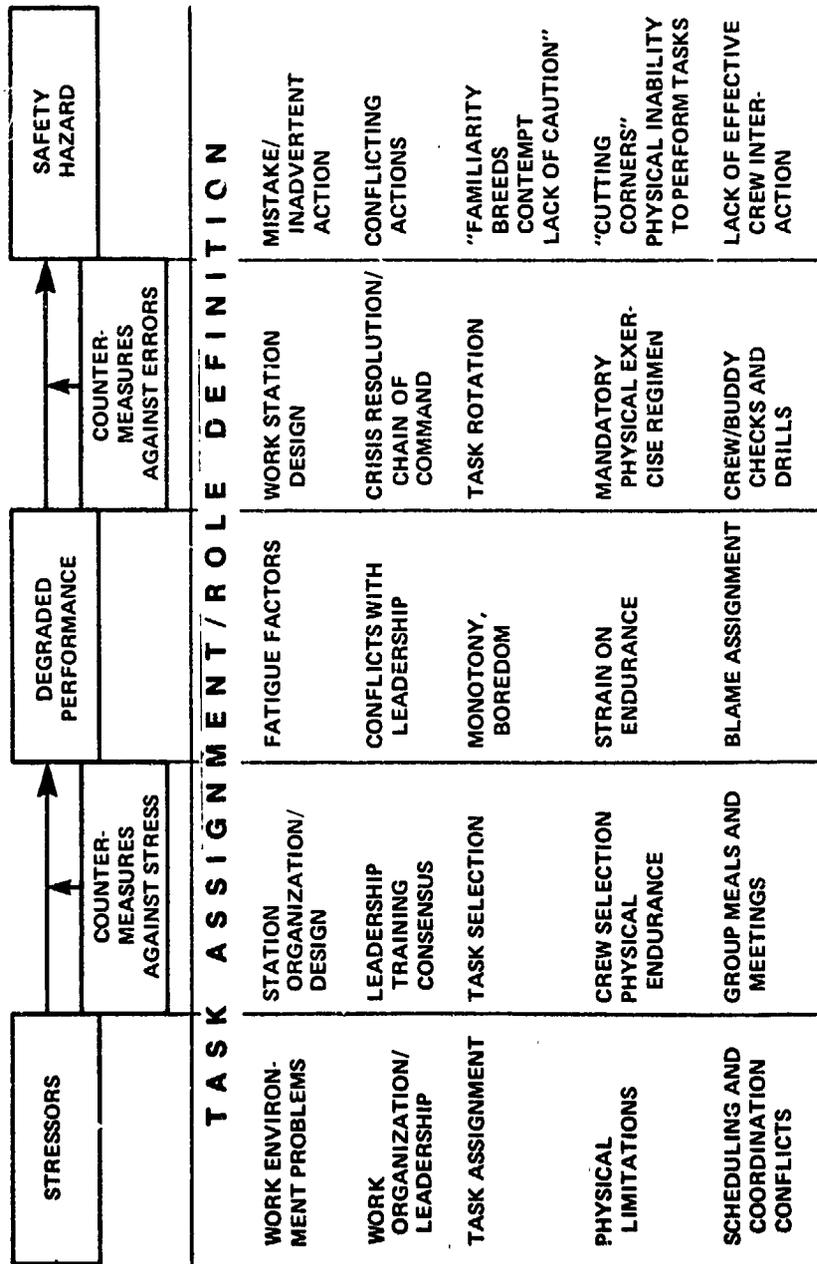
CRITICAL HABITABILITY II



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3. TASK RELATED ISSUES



EVA ROUTINES AND PROCEDURES

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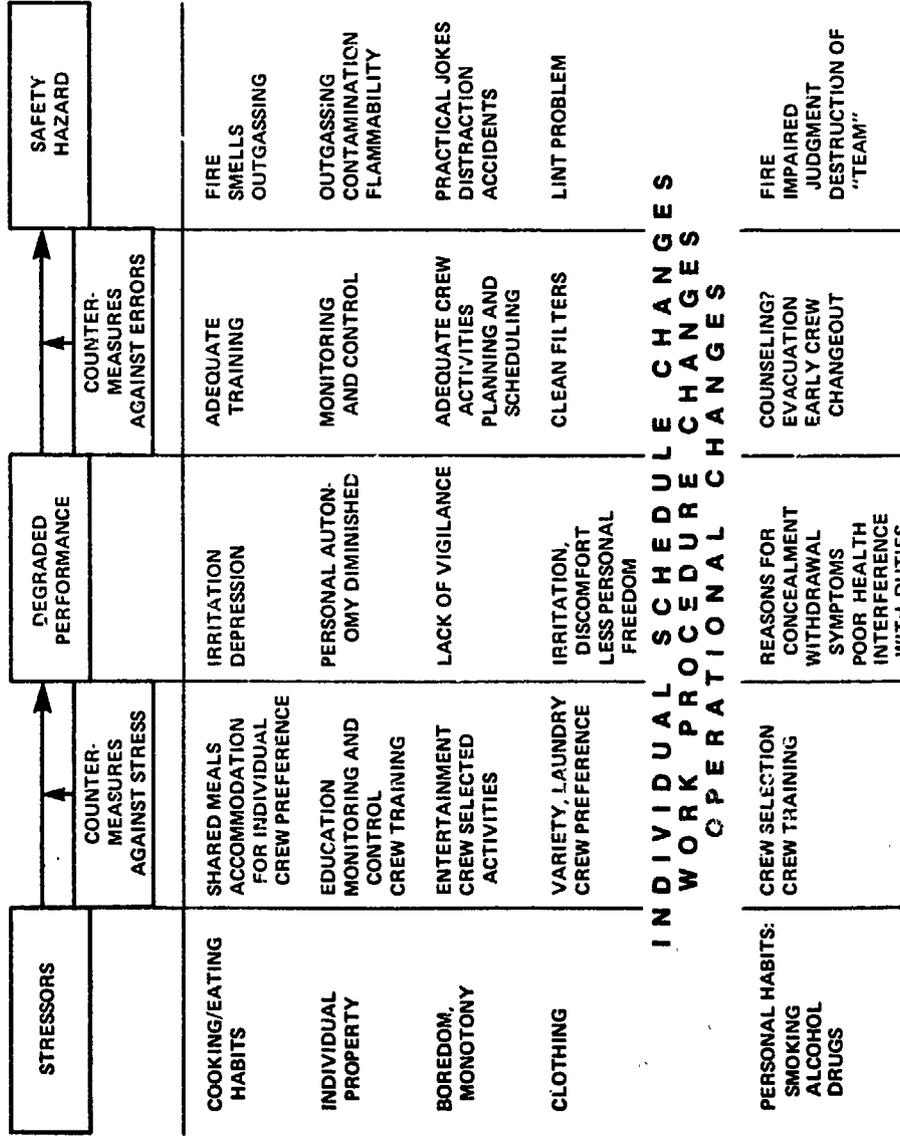
4. CREW INCAPACITATION

STRESSORS	COUNTER-MEASURES AGAINST STRESS		DEGRADED PERFORMANCE	COUNTER-MEASURES AGAINST ERRORS		SAFETY HAZARD
SPACE SICKNESS GAS BUBBLES IN WATER	SELECTION/ ADJUSTMENT MAINTAIN/CHECK FUEL CELLS		RELIABILITY GAS PAINS	TREATMENT SLING WATER TO SEPARATE GAS		CREW FAILURE TO RESPOND
ILLNESS	EXAMINATIONS AND HEALTH MAINTENANCE PROGRAM		SHORT TERM INCAPACITATION	TREATMENT		CONTAGION?
INJURY	SPACE INDUSTRIAL SAFETY		LONG TERM INCAPACITATION	RETURN TO EARTH? STABILIZE ON ORBIT?		DISTRACTION OF OTHER CREW MEMBERS
EMOTIONAL/ MENTAL PROBLEM	CREW SELECTION GROUP TRAINING		STRAIN ON OTHERS/ LACK OF TRUST	RELIEF FROM DUTY		SOCIALLY DEVIANT BEHAVIOR?
FAILURE IN LIFE SUPPORT SYSTEM	ABANDON, EVACUATE ONE MODULE		CONFINEMENT, TRAUMA	REPAIRS, REPLACE- MENT		LOSS OF ACCESS TO CRITICAL FUNCTIONS
DEATH	COUNSELING		TRAUMA TO CREW DISRUPTION OF TEAMWORK	COUNSELING		PRESERVATION OR DISPOSAL OF BODY LACK OF EXPERTISE ON BOARD

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5. PERSONAL CHOICE



INDIVIDUAL SCHEDULE CHANGES WORK PROCEDURE CHANGES OPERATIONAL CHANGES